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Electronic "Aperture Control" Devised for Solid State Imaging System

An electronic means of performing the equivalent of automatic aperture control has been devised for the new class of television cameras that incorporate a solid state imaging device in the form of phototransistor mosaic sensors, as described in Tech Brief 66-10112. The control system enables the sensors to detect a useful gray scale, positioned over a wide range of viewing light levels, without requiring either variation of the lens opening or automatic gain control of a video amplifier. Operation of the system involves controlling the effective limits over which time integration of the light incident on each image point takes place in its corresponding sensor element.

In this system, variation of the integration period to give electronic aperture control is achieved by varying the system frame rate. Thus, a voltage controlled oscillator acting as the master clock for stepping the digitally sequenced interrogation circuits can be servo controlled from a separate video detector. This detector is matched to the entire frame so as to set the frame time to the proper interval for the average of all picture elements to reach an optimum video level. The upper limit of control, representing the highest light level to which the upper end of the system dynamic range can be set, is an integration period in which total discharging is caused by that intensity for which steady state photoresponse is more significant than the transient response. The dynamic range that can be displayed at this setting is limited by any mosaic commutator inaccuracies and nonlinearities of subsequent video processing circuits. The lower extreme is a frame time setting for which the discharging due to junction leakage is still insignificant compared to the lowest shade of gray in a useful range of light levels.

Control by varying the frame rate complicates the task of image reconstruction and display. With standard real time cathode ray tube display, the lower frame rates required for sensing at very dim light levels produce objectionable shading and flicker. However, many television applications for which this method of light level control is pertinent also involve recording of all video data before display. There are a number of scan conversion techniques for displaying slow-scan data at viewable raster rates which can be employed with this control system. (See for example Tech Brief B67-10676 "Scan Rate Converter for Tape Recording and Playback of TV Pictures.")

Notes:

1. Two alternative methods of electronic "aperture control" are: (1) control of the total charge in the sensor for light integration by varying the bias pulse amplitude to vary the range of useful input light; this method has the disadvantage of requiring video gain control; (2) control of the total available charge by varying either the charge time (readout period) or the charging impedance; this alternative method has some objectionable image holdover from frame to frame.
2. Inquiries concerning this invention may be directed to:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B68-10028

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

(continued overleaf)

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